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(54) Improvements to recoil systems.

(57) A unit (2) is employed in a recoil system for large-calibre ordnance, for handling, storing and using the recoil energy of a gun by means of liquid-hydraulics. The unit effectuates damping of the recoil system during its rearward movement under simultaneous storage of energy obtained from the recoil kinetic energy of the recoil system. The unit (2) is disposed, with the aid of the thus stored energy, to supply energy to the recoil system on its recuperative movement which follows upon the recoil movement. The unit (2) may also supply energy to other energy consumers disposed on or in the proximity of the gun. The unit may also receive additional energy in the event of energy supply needs.

EP 0 491 106 A1

TECHNICAL FIELD

The present invention relates to a device in recoil systems for large-calibre ordnance.

BACKGROUND ART

In large-calibre ordnance, the recoil system must be arrested on firing of the weapon, when the system recoils. The system must thereafter be recuperated to a starting position. These functions are well known in the gunnery art and are provided for in different ways on the gun.

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

In the ongoing progressive development of ordnance, wishes have been expressed that the gun and its component parts be designed in a technically simple manner and yet with smoothly operating and few parts/components. Damping and recuperating of the recoil system in a gun have hitherto been designed in relatively complex manners. Moreover, at low rates of fire (low ramming speed), i.e. a long laying time, there is always excess energy

$$(w = \frac{m \times v^2}{2}),$$

while, conversely, at very high rates of fire there is insufficient energy for laying. In the latter case, external energy must be supplied. Hence, the above situation entails that there may be requirements for an energy equilibrium function.

SOLUTION

The primary object of the present invention is to propose a device which obviates the above-outlined problems and takes as its point of departure the capability, in one single unit, of effectuating damping of the recoil system at the same time as the unit participates in the recuperation function of the recoil system.

That which may essentially be considered as characterizing the novel device according to the present invention is that it consists of a unit which effectuates damping of the recoil system during its reverse movement while simultaneously storing energy derived from the recoil kinetic energy of the recoil system; and that the unit is operative, with the aid of the thus stored energy, to supply energy to the recoil system on its recuperative movement which follows upon the recoil movement.

In cases of high recoil impetus, high energy and low mass, the recoil system may be tapped of accumulated (hydraulic) energy for other energy users located on the weapon or in the vicinity thereof, for example loaders, lifting hoists for ammunition handling, etc. Any surplus energy which occurs between recoil and recuperation may thus be employed for other purposes within the ordnance system, for example limbering of field gun carriages and, by selection of suitable precharges, firing of the gun using different charges.

According to one embodiment of the present invention, the unit comprises a forward cylinder and an accumulator cylinder connected thereto. In such instance, the forward cylinder encloses a recoil piston which, via a recoil piston rod, is connected to the recoil system. The recoil piston is provided with an integrated recuperation piston and, moreover, there is disposed, ahead of the piston, a floating recuperation accelerator piston. This latter includes a central recess in which the recuperation piston is longitudinally displaceable. On actuation of the recoil piston from the recoil system, in this recoiling movement, working medium ahead of the recoil piston is compressed and acts on the recuperation accelerator piston which, in turn, forces working media into the accumulator cylinder for storing energy in the accumulator cylinder. The unit further comprises one or more shunt channels which lead working medium past the recuperation accelerator piston when the recoil piston compresses the working medium. Each respective channel includes a spring-biased one-way valve, via which the working medium passes into the accumulator cylinder for storage of energy in the accumulator cylinder.

The acceleration recuperation piston participates in the recuperation function of the recoil system, the piston being, in this position, actuated by the energy stored in the accumulator. The integrated recuperation piston also participates in the recuperation function and, when the acceleration piston has reached its end position, the integrated piston occasions a constant velocity in the recoil system until this is arrested. Working medium is replenished in a space behind the recoil piston on its recoil movement. This replenishment takes place via a non-return valve which is open when the piston moves because of the retractory movement in the recoil system, and is closed during the recuperation movement of the piston. The unit comprises or cooperates with/is connected to, a second valve via which working medium is replenished in the event of shortage thereof when the recoil piston executes its recuperation movement.

ADVANTAGES

The novel features as set forth above will realize an extremely simple design of the unit exercising the damping and recuperation operations, from which unit energy may, moreover, be tapped for other users. Hence, the unit includes cylinders, pistons and non-return valves and handles, stores and uses the recoil energy of a gun with the aid of these components and working medium employed, for instance hydraulic fluid, compressed air etc.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The nature of the present invention and its aspects will be more readily understood from the following brief description of the accompanying Drawings, and discussion relating thereto.

In the accompanying Drawings:

Figs. 1-3 show both the basic connection of the unit to the recoil system in a gun, and other functional stages which show int. al. how the unit, during simultaneous damping of the recoil system, stores the recoil energy of the gun on the recuperatory movement of the system, and utilizes this energy for the recuperation function and for supplying other users; and

Fig. 4 is a longitudinal cross-section showing one concrete embodiment of the unit according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the Drawings, the recoil system is indicated by reference numeral 1 in Figs. 1-3. A unit 2 according to the invention is connected to the recoil system via a piston rod or ram 3. Anchorage of the piston rod in the recoil system may be effected at a suitable position and in a per se known manner. Fig. 1 illustrates the case in which the recoil system, in connection with the gun discharging a round, begins to move rearwardly in the direction of the arrow 4. A storage function is symbolized by reference numeral 2a. The force or energy which the recoil system 1 now begins to transmit to the unit is indicated by reference numeral 5 and will, hereinafter, be referred to as recoil energy. In Fig. 2, the recoil system has reached its rearmost end position, entailing that energy has been stored in the energy storage function 2a of the unit 2. In this position, the unit 2 begins to exercise its recuperation function on the recoil system in the direction of movement shown by reference numeral 6. Fig 3 shows an intermediate position at which the recoil system has advanced a distance towards its fully recuperated starting position in the weapon. In this functional phase, it is shown how the stored energy may be employed partly for supplying power to the recoil system in its recuperative function, see arrow 7, and partly for supplying a unit 8 connected to the unit 2 and representing another function or unit within the weapon than the recuperation function/the recoil system, for instance a hoist for ammunition handling. The power/energy supply arrow is indicated by reference numeral 9. In one embodiment, a plurality of users may be supplied, and, in Fig. 3, an additional user designated 10 has been shown by broken lines. The unit according to Fig. 4 is based on the following fixed parts: cylinder 11, front end wall 12, rear end wall with accumulator cylinder 13. The unit also comprises the following moving parts, recoil piston rod with recoil piston 14, with integrated recuperation piston 15, recuperation acceleration piston 16, non-return valve means 17 with one or more return springs 18, floating piston 19 in the pressure accumulator and two non-return valves 20 and 21. In the figure, the recoil piston rod has been given the same reference numeral 3 as in Figs. 1-4.

In Fig. 4, the unit assumes a position where the recoil piston 14 of the recoil system is actuated inwardly via the piston rod 3 (to the right in Fig. 4) in relation to the above-mentioned fixed parts. A working medium, for instance hydraulic fluid or other medium is, in this instance, compressed in a space 22 ahead of the piston 14. The pressure elevation in the space 22 entails that the piston 16 is actuated towards its outer position (to the right in Fig. 4) which is determined by co-operation between an end surface 16a and an inner arrest surface 13a on an inner wall 13b in the unit. When the piston 16 reaches its end position, the pistons 14, 15 may move in relation to the piston 16 in that the piston 15 is journalled and longitudinally displaceable in a central recess 16b in the piston 16. The piston 15 is pin-shaped and is secured to the piston 14 at its centre so that the longitudinal axes of the pistons 14 and 15 coincide. At the above-mentioned centre, the piston 14 is provided with a central recess 14a in which the piston 16 may be partly inserted in the above-mentioned outer end position so that end position damping is achieved.

The unit is also fitted with one or more inner channels 23 disposed in the cylinder 11 so that they shunt working medium past the piston 16 during the compression movement. The non-return valve means 17 is actuated to its open position against the action of the return spring 18 on this compression. Working medium in the space 22a ahead of the pistons 14, 15 and 16 may, as a result of the illustrated arrangement, flow in via recesses 24 and 25 in the above-mentioned wall 13b to the liquid space 13c of the accumulator cylinder. The piston 16 has a forward flared portion 16c which is journalled in an inner wall surface 11a on the fixed cylinder 11. At the outer end position of the piston

16 an annular space 22b is defined, in which the non-return valve means 17 operates, by the piston 16, apart from at a small circular gap between the centre aperture of the disk-shaped non-return valve means and the above-mentioned flared portion 16c. The space behind the portion 16c is connected to an external tank or reservoir via a channel 11d.

The arrangement entails that liquid is compressed in the space 13c of the accumulator, with the result that the floating piston 19 of the accumulator is displaced towards the gas space 13d of the accumulator and causes compression of the gas in the pressure accumulator 13.

The unit is connected to an external tank or reservoir (the unit according to Figs. 1-3), which is connected via connections 2a, 26, 11c, 11d. The non-return valve 20 is disposed in the connection 2a. Like the connection 26, this connection 2a is connected to the external hydraulic system. When the piston 14 moves to the right in the figure, the non-return valve 20 opens the communication 2a and working medium for the exterior system may flow in via the channel 2a and, once an annular recess 22c has been exposed by the recoil piston 14, also via the connection 26. When the piston 14 moves from an outer end position (the position to the right in Fig. 4) the non-return valve 20 closes, entailing that efficient and gentle braking is achieved by a medium (hydraulic fluid) enclosed in a space 27.

When the pistons 14, 15 and 16 assume their outer positions at which the energy stored in the accumulator is at its greatest, the recoil system will have been arrested by the unit and reached its rearmost position. The unit thereafter begins to effectuate energy transmission to the recuperation function of the system. The stored energy in the accumulator actuates the recuperation piston 15 and the acceleration recuperation piston 16, of which the latter accelerates the forwardly recuperating recoil system. In such instance, the non-return valve means 17 is closed. When the piston 16 reaches its innermost position as determined by the co-operation between an inner space 11b and the flared portion 16c of the piston 16, the piston 15 alone takes over the recuperation function and supplies energy at constant speed until such time as the piston 14 is braked in brake grooves. Any possible shortage of liquid in the space 22 will be compensated for through the non-return valve 21 which is closed when the piston 14 moves to the right in the figure and compresses the working medium in the space 22, and opens when the piston moves to the left in Fig. 4 and causes reduced pressure in the space 22. Replenishment of liquid takes place from an external tank or reservoir via a channel 11c in which the non-return valve 21 is disposed.

Secondary devices or systems may be supplied by a channel or channels 111. The medium tapped in this instance is recycled to the above-mentioned exterior tank or reservoir for re-use. In the event of energy requirements, energy may, on the other hand, be supplied via the channel or channels 111. Tapping in connection with supply of secondary systems takes place via a non-return valve 112. Replenishment for energy supply is effected by means of an operating valve 113 which, in one position (i.e. the position as shown in Fig. 4), shunts the non-return valve, and in a second position activates the non-return valve. The operating valve receives electric control signals in response to whether energy supply or energy tapping, respectively, is to take place. According to the present invention, it is also proposed that the mass (m) should be kept low in relevant parts, which may be effected by employing composite materials.

Thus, employment of the present invention will realize the unique advantage that between, during, before and after each round or salvo, the pressure levels in the spaces 13c, 13d and 22 may, from an external pump or external tapping, be regulated through the channels 111 and 11c. Moreover, the charging volume/charging pressure of the pressure accumulator may also be regulated.

Different types of working medium may be employed such as gas, (e.g. air, freon, argon) and liquid (e.g. water, glycol, oil, silicon) and suitable mixtures thereof.

The fixed parts 11, 12 and 13 are united and mutually sealed in a per se known manner. Similarly, the pistons and the piston rod 3 are sealed by sealing means of per se known types and in per se known manners.

The tank or reservoir which is connected to the channels 2a, 26, 11c and 11d consists of a tank with atmospheric aeration.

The present invention should not be considered as restricted to that described in the foregoing and shown on the drawings, many modifications being conceivable without departing from the spirit and scope of the appended claims.

Claims

1. A device in a recoil system (1) for large-calibre ordinance, **characterized in that** it consists of a unit (2) which effectuates damping of the recoil system during its rearward movement (4), under simultaneous storage of energy obtained from the recoil kinetic energy of the recoil system; **that** the unit is disposed, with the aid of the thus stored energy, to supply energy to the recoil system on its recuperative movement (6) which follows upon the recoil

movement; **that** the unit includes a forward cylinder (11) and an accumulator cylinder (13) connected thereto; **that** the forward cylinder encloses a recoil piston (14) which, via a recoil piston rod, is connected to the recoil system; **that** the recoil piston is provided with an integrated recuperation piston (15); **that** there is provided, ahead of the recoil piston, a floating recuperation acceleration piston (16); **that**, on actuation of the recoil piston from the recoil system on this rearward movement, working medium is compressed ahead of the recoil piston and actuates the recuperation acceleration piston which, in its turn, forces in working medium into the accumulation cylinder for said storage of energy in the accumulator cylinder; **and that**, in the recuperation function of the recoil system, the acceleration recuperation piston participates, being, in this position, actuated by the energy stored in the accumulator cylinder (13), together with the integrated recuperation piston.

2. The device as claimed in Claim 1, **characterized in that** the unit also supplies energy to an energy user (8, 10) disposed on or in the proximity of the gun, for example loaders and rammers, hoists for ammunition handling, etc.

3. The device as claimed in Claim 1 or 2, **characterized in that** the unit handles, stores and consumes the kinetic energy of the weapon either hydraulically or pneumatically.

4. The device as claimed in Claim 1, 2 or 3, **characterized in that** the recuperation acceleration piston comprises a central recess (16a) in which the recuperation piston is longitudinally displaceable.

5. The device as claimed in Claim 1, 2 or 3, **characterized in that** on the recuperation (6) of the recoil system in which the accumulator cylinder actuates the acceleration recuperation piston (16) and said integrated recuperation piston (15) by means of its stored energy, the latter piston causes, after movement of the acceleration recuperation piston, a constant actuation of the recoil system.

6. The device as claimed in any one of the preceding Claims, **characterized in that** working medium may be led off on surplus energy generated by the device and may be supplied on the occurrence of a shortage of energy in the device via one or more lead-off and supply channels, respectively (111), one or more of said channels being fitted with a non-return valve (112).

7. The device as claimed in any one of the preceding Claims, **characterized in that** working medium may be replenished in the space (22) ahead of the piston by the intermediary of the second non-return valve (21) which is closed on recoil movement of the recoil piston and open on recuperative movement.

Fig. 1

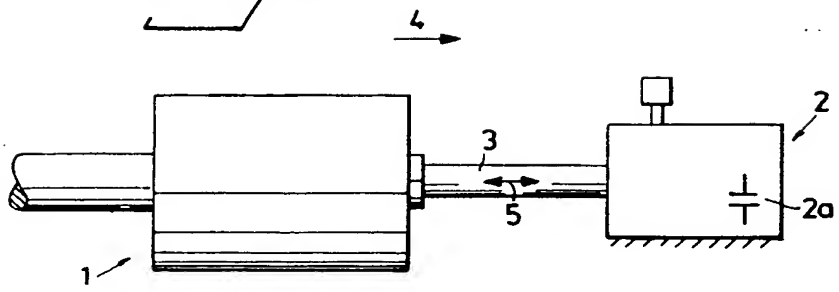


Fig. 2

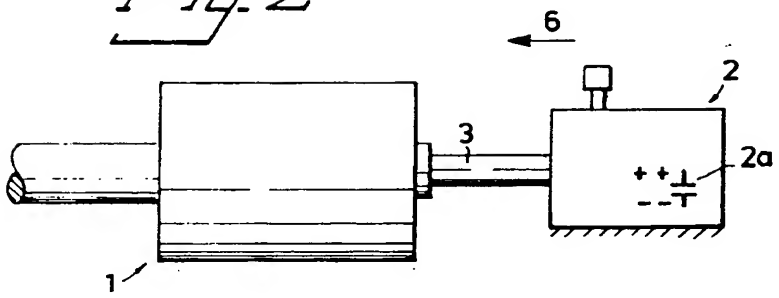


Fig. 3

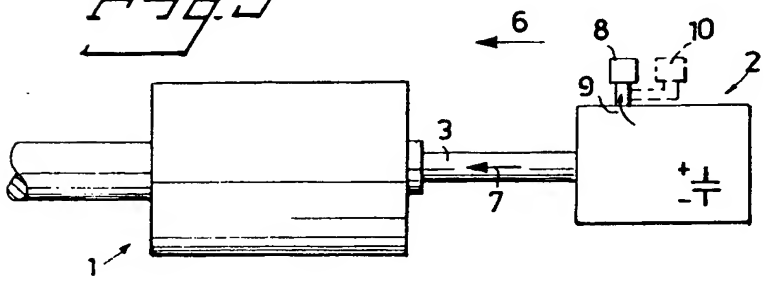
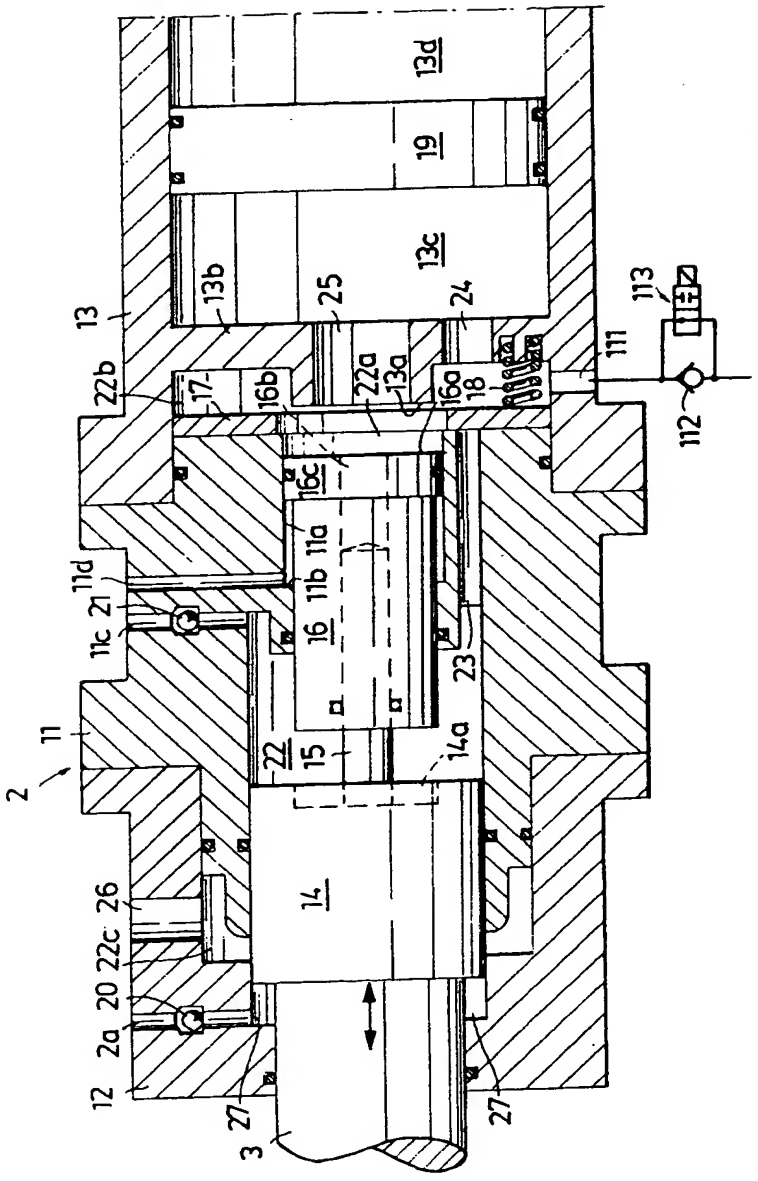


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number

EP 90 85 0409

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 022 335 (GENERAL ELECTRIC CO.) * Page 5, line 5 - page 9, line 14; figures *	1,2,3	F 41 A 25/20
A	DE-A-2 335 649 (RHEINMETALL GmbH) * Page 3, line 14 - page 4, line 10; figures *	1,2,3	
A	US-A-3 638 526 (H. KLAPDOHR) * Column 1, line 64 - column 2, line 37; figure *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F 41 A
F 16 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31-07-1991	OLSSON B.G.I.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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